damage it is well established that it often happens that there is very little damage in areas in the path of a light wind carrying smoke and serious damage will result in other areas not so protected. The effect of a smoke protection can be easily observed every year if the trouble is taken to visit different areas in the same vicinity. Directly west of Des Moines is a large open area more than one-half mile wide. In this area the effects of frost are observed early and there is never any smoke to ward off an injury in a critical condition. Rather early during September, 1929, a frost occurred that killed practically everything in the unprotected area. In advancing eastward the extreme edge of the city showed only traces of frost and as the city was penetrated even the most tender vegetation was not injured in the least and continued to thrive for more than a month after areas immediately adjoining were entirely without vitality.

In order to obtain positive information, reliable instruments were exposed for a time several years ago, to see just how much temperature readings in the open country and the city exposure differed, the exposures being less than 5 miles apart. It was disclosed that when conditions were favorable for radiation in the country and the city was covered with a smoke blanket, the readings were never less than 5°, most of the time they were 10°, or more, and on one occasion a difference of 17° was noted, ranging from 35° at the country exposure to 52° at the Weather Bureau office. A great deal of the climatological data that is being compiled is, at best faulty, and it would seem that the time has come when the question of securing more accurate climatological data should receive some serious thought. The principle of smoke and artificial heating is made use of on a large scale as a protection against frost at many places, particularly in the far Western States, when the crops are in danger. It is known with a great deal of certainty just how much heat may be produced in a given case and it would seem as logical to consider the artificial conditions produced in these orchards in determining their climatology as accepting the data from smoke-infested cities as being the climatological record of them. No absolute solution seems possible but it is thought that stations at, or near, air ports would offer the best solution. The situation complained of in the larger cities is gradually being felt more and more at a large number of cooperative stations. There are, however, a few cooperative stations with which comparison can be made with Weather Bureau stations that are troubled by smoke. The cooperative stations are as near natural as is possible to find anywhere. Each cooperative station is compared with the nearest regular Weather Bureau station. The average absolute minima for each month was taken and the city influence on the minima is apparent at once.

*Table showing extreme minima at Weather Bureau stations and selected cooperative stations, period 1925–1928, inclusive*

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Decorah | −17 | −8 | 2 | 15 | 30 | 37 | 44 | 43 | 30 | 14 | 8 | −16 |
| Dubuque | −11 | 1 | 8 | 21 | 38 | 46 | 52 | 51 | 37 | 24 | 14 | −8 |

Average monthly difference in extreme minima, 7.7°.

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Davenport | −9 | 7 | 9 | 24 | 37 | 47 | 52 | 52 | 38 | 24 | 14 | −6 |
| Sigourney | 11 | 5 | 8 | 22 | 35 | 45 | 50 | 50 | 34 | 20 | 11 | 7 |

Average monthly difference in extreme minima, 2.2°.

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Des Moines | −7 | 1 | 11 | 28 | 37 | 48 | 55 | 52 | 37 | 23 | 12 | −6 |
| Winterset | −13 | −1 | 6 | 20 | 28 | 41 | 47 | 45 | 32 | 17 | 8 | −9 |

Average monthly difference in extreme minima, 5.8°.

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Omaha | −7 | 4 | 13 | 27 | 40 | 51 | 57 | 54 | 39 | 26 | 14 | −4 |
| Glenwood | −9 | 3 | 10 | 24 | 34 | 46 | 51 | 46 | 34 | 20 | 9 | −5 |

Average monthly difference in extreme minima, 4.2°.

*Average minima and monthly means at Davenport and Davenport No. 2 for the period 1924–1928, inclusive*

EXTREME MINIMA

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Davenport | −11 | 7 | 10 | 25 | 39 | 48 | 53 | 54 | 39 | 27 | 12 | −7 |
| Davenport No. 2 | −13 | 5 | 8 | 23 | 34 | 45 | 48 | 49 | 35 | 23 | 9 | −11 |

Average monthly difference, 3.4°.

AVERAGE MONTHLY MEANS

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Davenport [1] | 22.9 | 31.0 | 37.7 | 50.1 | 60.4 | 68.4 | 74.6 | 73.2 | 65.4 | 53.9 | 39.2 | 24.5 |
| Davenport No. 2 [2] | 23.0 | 31.2 | 38.2 | 50.8 | 60.9 | 68.3 | 74.6 | 73.2 | 65.8 | 53.6 | 39.5 | 24.3 |

[1] Annual, 50.1. [2] Annual, 50.3.

# THUNDERSTORM TOP KNOTS

By CHAS. F. BROOKS

[Clark University, Worcester, Mass.]

A perfectly formed cumulo-nimbus cloud housing a small but energetic thunderstorm passed within hearing distance south of Greenwich, Conn., the evening of July 11, 1930. At the time of its best development, 7:15–7:25 p. m., eastern standard time the heavy vertical mass of the thunderstorm was probably 10 km.[1] wide from east to west. The outspreading top sheet of heavy mammato-alto-stratus extended about 3 km. on either side. The convective air, most active in the front and in the rear portions of the south-eastward advancing storm and the outspreading top, was more or less a double affair spreading from these two sections. The vertical thickness of the top sheet was of the order of 1½ km., and the height of the top at least 6 km.

Above the western trunk of active convection a cumulus knob would appear rather rapidly, grow upward to a height of ½–1km. above the level of the top, then fall back, the complete process taking from 3 to 5 minutes. While the top knot was growing lightning was visible in it every 3 to 15 seconds, but when it was falling back lightning was less frequent, and was of the order of one-half minute to a minute. Lightning in the trunk below the top knot was still more frequent.

As a particularly large knob at 8 p. m., eastern standard time, fell back into the mass of the top sheet, great mammato-cumulus forms appeared on the under surface of the top sheet. These mammato forms were about as large as the top knob itself had been, and were evidently from the air which had come from the upper protuberance and which was now falling back and spreading out. So

[1] All dimensions are based on rough angular measurements made from an elevation of about 100 m. and 4 km. from Long Island Sound, at Greenwich, Conn.

strong was the convection that apparently the upward moving air was carried considerably beyond the level of equilibrium. It would soon descend and spread out around the column of rising air. The descent produced not only the mammato-cumulus forms, which in this connection were unusually large, but also certain reactions in the top of the cloud sheet near by. Rain began at 6:15 p. m. with some electric display and continued as a moderate shower for 35 minutes with a light wind. About 6:45 p. m. thunder became loud and close and a scroll of heavy dark cloud appeared rolling down from the northwest. Excessive rain began at 6:50 and lasted 25 minutes. Small hail, about the size of peas, fell from 6:50 to 6:53 and the lightning became severe. The large hail fell from 8:05 to 8:10. Melon and cucumber leaves were cut in some cases with nearly round holes. Path of storm northwest-southeast, last thunder heard southeast about 7:40.

Two humps appeared on each side of the falling center, about ½ to 1 km. from it. The hump on the east grew to a new knob and then fell back to a level. This rise and fall took about five minutes.

Another knob grew, but still farther east, and fell back. Then still another arose immediately west of this position. This last knob was about 1 km. wide and ⅓–½ km. high. This formation of protuberances in one place and then another, which seemed to be chiefly the result of the oscillation following the first large one, occupied a period of 25 minutes.

Thereafter, the storm had so decreased in intensity with the oncoming of night and had moved so far away that no further action was seen.

*Intense thunder and hailstorm at Bridgehampton, Long Island.*—About 50 miles farther east another small local storm struck Bridgehampton, on Long Island, at this time. Intense local convection was evidently the order of the evening. Ernest S. Clowes, writing from that place, said it was one of the most severe he had seen in several years' residence there. The following is from his letter, with times changed from daylight saving to eastern standard.

Its distinguishing feature was hail, always a great rarity here, which fell for about five minutes, the stones mostly measuring up to ¾ inch to 1 inch in thickness, the lower figure being more common. Some jagged pieces of ice fell, one of which was reported as being 2 inches long, the measurement being made by ruler soon after the fall.

## NOTES, ABSTRACTS, AND REVIEWS

*Extreme July weather indicates August weather.*—Five times during the last 58 years in Iowa the State mean temperature for July has been 4° or more above normal, and in every case the mean temperature of August has been above normal; also there have been 3 cases when the July mean was 4° or more below normal and in each case the August mean was below normal, so extreme July temperatures have been followed by the same tendency in August 100 per cent of the time.

As to rainfall, there have been 8 cases in 58 years when the State average rainfall for July was 2 inches or more above normal and in 6 of the 8 cases, or 75 per cent, the average rainfall of the following August was above normal; also there were 6 cases when the average rainfall of July was 2 inches or more below normal and in 5 out of the 6 cases, or 83 per cent, the average rainfall of the following August was below normal.

Briefly, there seems to be a well-marked tendency for abnormal Iowa weather in July to perpetuate itself through August. In other Corn Belt States this weather sequence is not so well defined, though Missouri shows a tendency in that direction.—*C. D. R.*

*Iowa July mean temperatures 4° or more from normal (8 cases) and average rainfall 2 inches or more from normal (14 cases) in 58 years, 1873–1930; and departures from normal in the following August*

| Temperature | | | Rainfall | | |
|---|---|---|---|---|---|
| Year | July | Aug. | Year | July | Aug. |
| | ° | ° | | *Inches* | *Inches* |
| 1874 | +4.1 | +2.6 | 1875 | +2.22 | +0.60 |
| 1901 | +8.7 | +2.1 | 1876 | +2.32 | +1.71 |
| 1916 | +6.0 | +2.3 | 1896 | +3.07 | +.08 |
| 1921 | +4.2 | +.4 | 1900 | +2.32 | +1.21 |
| 1930 | +4.2 | +2.7 | 1902 | +4.84 | +3.14 |
| 1882 | −4.6 | −.2 | 1907 | +3.44 | +.89 |
| 1891 | −5.2 | −2.6 | 1915 | +4.49 | −.63 |
| 1915 | −4.2 | −5.8 | 1922 | +2.48 | −.38 |
| | | | 1886 | −3.33 | −1.42 |
| | | | 1894 | −3.20 | −1.86 |
| | | | 1913 | −2.01 | −.76 |
| | | | 1916 | −2.05 | −.86 |
| | | | 1923 | −2.08 | +1.98 |
| | | | 1930 | −2.34 | −1.02 |

*Pleistocene of northern Kentucky and other papers.*—This volume, put out by Dr. W. R. Jillson, State geologist of Kentucky, contains contributions by Frank Leverett on The Pleistocene of Northern Kentucky; The Climate of Kentucky, by S. S. Visher; Geology of the Southern part of the Dawson Triangle, by A. H. Sutton; The Cretaceous Deposits of Trigg, Lyon, and Livingston Counties of Kentucky, by J. K. Roberts; and the Geology and Physiography of the Mammoth Cave National Park. The preface is by the late T. C. Chamberlin.

Kentucky's position near the southern border of the glacial drift makes a study of the distribution of scattered bowlders and other evidence of glacial action beyond the border of continuous drift of special interest to students of the glacial history of our continent.

The chapter on climate by Dr. S. S. Visher covers 86 pages and is fully illustrated by 109 maps and diagrams. The statistical presentation is based on the records of 72 stations well distributed throughout the State for the period from the beginning of observations to 1922, inclusive. The length of record varies, therefore, from 63 at Lexington to 5 at Lynnville; the great majority of records, however, are more than 10 years in length.

Table No. 3 gives statistics of irregularities in the occurrence of precipitation. The following is abstracted from that table: Number of stations used, 72. The wettest year in Kentucky, as determined by the record of individual stations, was 1890, with 11 stations, or but 15 per cent of the total so reporting; the next wettest was 1919, with 14 per cent. The driest year was 1904, with 24 stations, or 33 per cent of the total, so reporting; the next driest was 1901, a year characterized by great heat and dryness in the great interior valleys. That year had but 12 stations, or 14 per cent of the total reporting the greatest drought of record.

The extremely local character of rainfall distribution may be realized when it is considered that for the 40-year period 1883–1922 one or more stations experienced the greatest rainfall in the life of the station in 25 of the 40 years, or in 62 per cent of the years—that is to say, some 1 of the 72 stations recorded the greatest rainfall during its life in one of the years considered and only 11 of the stations recorded their heaviest precipitation in the same year.

Dry years, as is well known, occur with more frequency than wet ones, as illustrated by the number of stations,